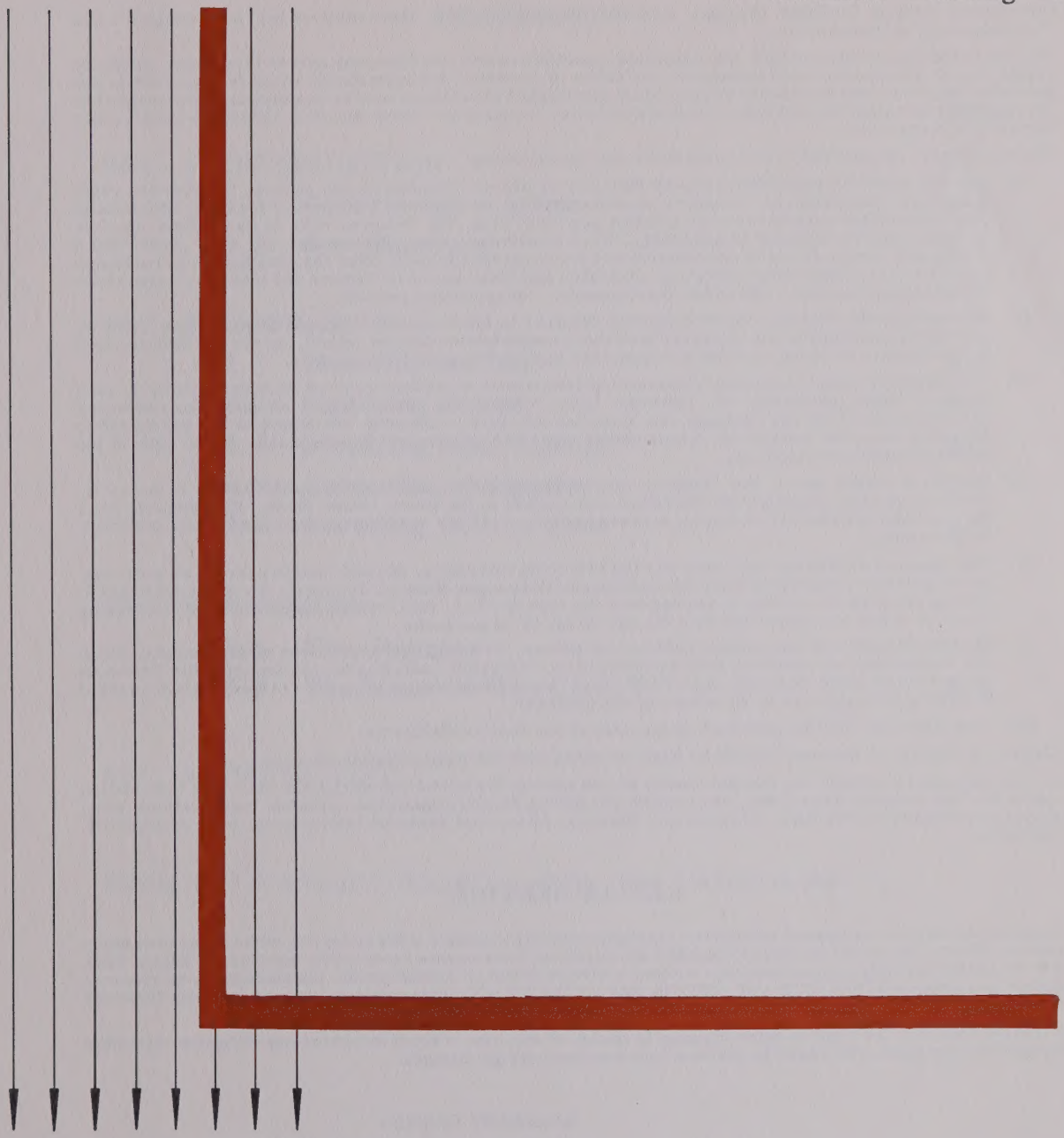
INSTRUCTION MANUAL

MODEL 862
Decimal Counting Unit



Beckman® INSTRUMENTS, INC.

BERKELEY DIVISION
2200 Wright Avenue
Richmond, California

November 1963

WARRANTY

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Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

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(b) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect, unless the item is found to be defective in which case the Company will pay all transportation charges.

(c) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.

(d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.

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(g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

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Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

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Model 862 Schematic Diagram, Dwg. No. D416916-Rev. A

SECTION 1

INTRODUCTION

1.1 GENERAL DESCRIPTION

The Model 862 DCU is a plug-in electronic counting unit using solid state components mounted on a printed circuit board. The unit provides a count of input pulses from zero to nine, each count being represented by output signals in binary (1-2-4-8) coded decimal form. With a Data Storage Unit (DSU) this binary-coded output can be converted into a decimal digit display of the registered count.

At every tenth input pulse, the DCU generates an output signal suitable to drive a Model 862 or a Model 860 DCU. Thus, any number of these units can be cascaded (the output of one connected to the input of the next) to form a counter whose total count capacity depends only on the number of DCU's.

Since each DCU generates one output pulse for every ten input pulses, these units can also be used as decade frequency dividers.

1.2 SPECIFICATIONS

See Table 1-1.

Table 1-1.

Count Indication	Binary-coded decimal (1-2-4-8) electrical signals.
Input Requirements	Positive pulse or voltage step, 6 volts to 8 volts amplitude (+7.0 recommended), 10 nanoseconds rise-time. Pulse duration 30 nanoseconds, minimum.
Counting Rate	0 - 5 mc.

continued.

Table 1-1 - continued

Output Characteristics	1-2-4-8 permuted binary code. Output available from one side of each binary. Voltage levels +0.2 volts and -9.0 volts. Binaries designed to drive maximum of 2 ma through 7.5K to the negative supply of -15 volts. Carry pulse output designed to drive a following Model 862 or 860 DCU. Designed to drive 1.5 ma into DSU from "off" side of binaries.
Reset Requirements	Negative pulse or voltage level change. Reset time held at 0 volts. At reset, line is driven to -10 volts for 10 micro-seconds.
Power Requirements	60 ma at -15 volts and 4.0 ma at +10 volts.
Transfer Time	60 nanoseconds between application of tenth input pulse and start of output pulse.
Transistors	Germanium: eight 2N961 and, one 2N1143.
Dimensions	1/2" wide. 3-11/16" high, 3-5/32" deep.
Weight	1-1/2 oz.
Connector Required	UCINITE 119510-MP-15C. Beckman Stock No. 680-815353.

SECTION 2

OPERATION

2.1 MOUNTING THE UNIT

The DCU plugs into a 15-pin printed-card connector. Typical connector: Ucinite 119510-MP-15C.

2.2 SUPPLYING POWER

Ordinarily, the unit operates with supply voltages of -15 volts and +10 volts. The negative voltage supply connects to pin K of the DCU connector, and the positive supply to pin J. Supply voltage tolerance ±10%.

2.3 SUPPLYING INPUT SIGNALS

Connect the input signal to pin C of the DCU connector. The unit registers a count each time a pulse +6 to +8 volts in amplitude (with a minimum width of 30 nanoseconds and 10 nanoseconds rise time) is applied to the input terminal.

Pin A (capacitor bypass) provides an alternate input. If used, this input should be driven through an external capacitor.

2.4 USING OUTPUT SIGNALS

Each of the DCU's four binaries supply readout signals in two forms: with a B- supply of -15 volts, -12 volts with respect to ground (pin S) for a binary "one", and -0.3 volts with respect to ground for a binary "zero". The binary states of "one" or "zero" indicate the registered count in 1-2-4-8 binary coded decimal. Each readout line will supply a maximum steady state current of 2 ma into a load connected to B-. Table 2-1 represents the binary state for each registered count from 0 to 9.

The readout signals at terminals D, F, M, and P, can be used to drive the DSU for a visual indication of the registered count. In addition, the output signal produced at terminal R each time the count goes from 9 to 0 can drive either a Model 860 or 862 DCU, or other circuitry.

Table 2-1. State of the Binaries

DECIMAL DIGIT REGISTERED	FIRST BINARY STAGE (Weight 1)	SECOND BINARY STAGE (Weight 2)	THIRD BINARY STAGE (Weight 4)	FOURTH BINARY STAGE (Weight 8)
0	0	0	0	0
1	1	0	0	0
2	0	1	0	0
3	1	1	0	0
4	0	0	1	0
5	1	0	1	0
6	0	1	1	0
7	1	1	1	0
8	0	0	0	1
9	1	0	0	1

Use Table 2-1 to convert a coded digit to a decimal digit. Note the weight of each column in which a "1" appears, then sum the weights. For example, the coded digit "1010" is equivalent to 1+0+4+0 = 5; and "1001" is equivalent to 1+0+0+8 = 9.

2.5 RESETTING DCU TO ZERO

Reset line (pin L) is clamped at zero volts while the DCU counts. Applying a negative pulse to pin L resets the DCU to zero.

SECTION 3

CIRCUITS

3.1 THE BINARIES

The decimal counting unit consists of four binaries, each comprising a pair of PNP transistors, connected in a scale-of-ten circuit. The binaries have two stable states and are alternately triggered from one state to the other by successive input pulses.

In a PNP transistor, the input impedance is low (in the order of a thousand ohms) when the base potential is negative. This low input impedance permits a base current to flow and the transistor conducts. On the other hand, a positive base potential results in a high input impedance (several hundred thousand ohms). Consequently, no base current flows and the transistor is cut off.

Assume, for example, that the first binary on the schematic diagram is initially in the "zero" state. In this state, Q2 is conducting while Q1 is cut off. A positive input pulse applied through diode CR4 to the base of Q2 drives this transistor to cutoff.

The pulse applied to CR2 and CR4 has no effect on the state of Q1 since this transistor is already cut off.

As the load current in Q2 decreases, the potential on its collector approaches B-. This change in voltage level, coupled through resistor R5 and capacitor C3 to the base of transistor Q1, drives Q1 into the active region. As a result, Q1 begins to conduct, and the amplified current flowing through R1 causes the potential on the collector to fall to almost zero. Under these conditions, the diode base clamp CR5 combined with the divider network R2 and R6 maintains a positive potential at the base of Q2 to keep it cut off.

The binary, now in the "one" state, remains in this stable state until the next positive input pulse arrives. At that time, Q1 cuts off, Q2 conducts, and the binary resumes its original state.

The collector of each "normally off" transistor in the four binaries connects to a corresponding terminal of the DCU connector. Thus, the change in voltage level at each collector, as the binary changes state, is available as an output signal. The change in voltage level at the collector of each "normally on" transistor is used as the drive signal to the next binary. Therefore, each binary in the DCU reverses state for every two reversals of the preceding binary.

3.2 THE SCALE-OF-TEN CIRCUIT

The scale-of-ten circuit used in the Model 862 DCU is a four-place binary counter wired so that it resets to zero on every tenth input pulse. Operation is explained in detail in the following paragraphs.

3.2.1 Initial Conditions and Circuit Fundamentals

Under initial conditions, transistors Q2, Q4, Q6, and Q8 are saturated. Transistors Q1, Q3, Q5, and Q7 are cut off. These conditions define the "zero" state for each binary.

At this point, a review of transistor binary (flip-flop) circuit fundamentals may be helpful in understanding the circuit description in the following paragraphs.

Consider the first binary, transistors Q1 and Q2. Under initial conditions, Q1 is cut off and Q2 is saturated. Transistor Q1 is held at cutoff by divider network R3, R5, and clamp CR1. A positive input pulse applied at the junction of CR2 and CR4, has no effect on Q1 since it is already cut off. While Q2 is saturated, its collector is near ground potential. Now, when the positive input pulse is applied through CR4 to the base of Q2, it drives Q2 into cutoff and the collector potential decreases to approximately -12 volts. This negative transient, coupled to the base of Q1 through crossover network R5 and C3, drives Q1 into saturation.

Thus, on the first input pulse, the first binary "flips" and its transistors reverse their states. But the second binary is not affected since it takes a positive output pulse from the binary to cause the second binary to flip.

But on application of the second input pulse, circuit action produces a positive output signal to flip the second binary, as follows: the positive input pulse goes through CR2 to the base of Q1 to cut it off. As Q1 cuts off, its collector potential drops to approximately -12 volts. This negative transient, coupled to the base of Q2 through crossover network R2 and C1, drives Q2 into saturation. When Q2 saturates, the collector potential goes from approximately -12 volts to approximately -0.2 volts. This positive transient passes through C6 and CR8 to trigger the second binary. To summarize: a positive pulse applied to the first binary will cut off the saturated transistor, and regenerative action will drive the cutoff transistor into saturation. The first binary will produce a driving pulse to the second binary only when the second transistor of the first binary goes from cutoff to saturation. Thus, the first binary will produce an output pulse only on every second input pulse, even though every input pulse will reverse the state of the binary. These principles apply to all of the binaries.

3.2.2 Sequence of Operation

Pulse No.	Action
1	First binary flips. Q2 turns off. No output signal.
2	First binary flips. Q2 saturates. Output pulse flips second binary. Q4 turns off.
3	First binary flips. Q2 turns off. No output signal.
4	First binary flips. Q2 saturates. Output pulse from Q2 flips second binary. Q4 saturates. Output pulse from Q4 flips third binary and Q6 cuts off.
5	First binary flips. Q2 turns off. No output pulse from Q2.
6	First binary flips. Q2 saturates. Output signal from Q2 flips second binary. Q4 turns off. No output pulse from Q4.
7	First binary flips. No output signal from Q2.
8	First binary flips. Q2 saturates. Output pulse from Q2 flips second binary. Q4 saturates. Output pulse from Q4 flips third binary. Q6 saturates. Output pulse from Q6 flips fourth binary. Q8 cuts off. Negative 12 volts at collector of Q8 is applied to CR9 and CR6 closing the gate.
9	First binary flips. No output from Q2.
10	First binary flips. Q2 saturates. Output signal from Q2 is blocked from second binary by closed gate CR9 and CR6. So it goes through C14 and CR9 to flip the fourth binary. Q8 saturates. The output pulse from Q8 goes through emitter follower Q9 to output (pin R).

3.2.3 Summary

At the tenth input pulse, all four binaries are in the "zero" state and the DCU is ready for the next counting cycle. The positive output signal from transistor Q8, produced when the counter goes from nine to zero, can drive a Model 860 or 862 DCU. Thus, the counter will supply one input pulse to the next DCU for every ten counts registered.

The number of counts registered by the DCU is represented in binary-coded decimal form by the potentials on the readout line of the binaries.

Reset line L connects to the base of the normally-on transistors (Q2, Q4, Q6, and Q8) in each binary. A negative voltage pulse applied to these reset lines will cause the normally-on transistors to conduct and trigger all binaries to the zero state.

SECTION 4

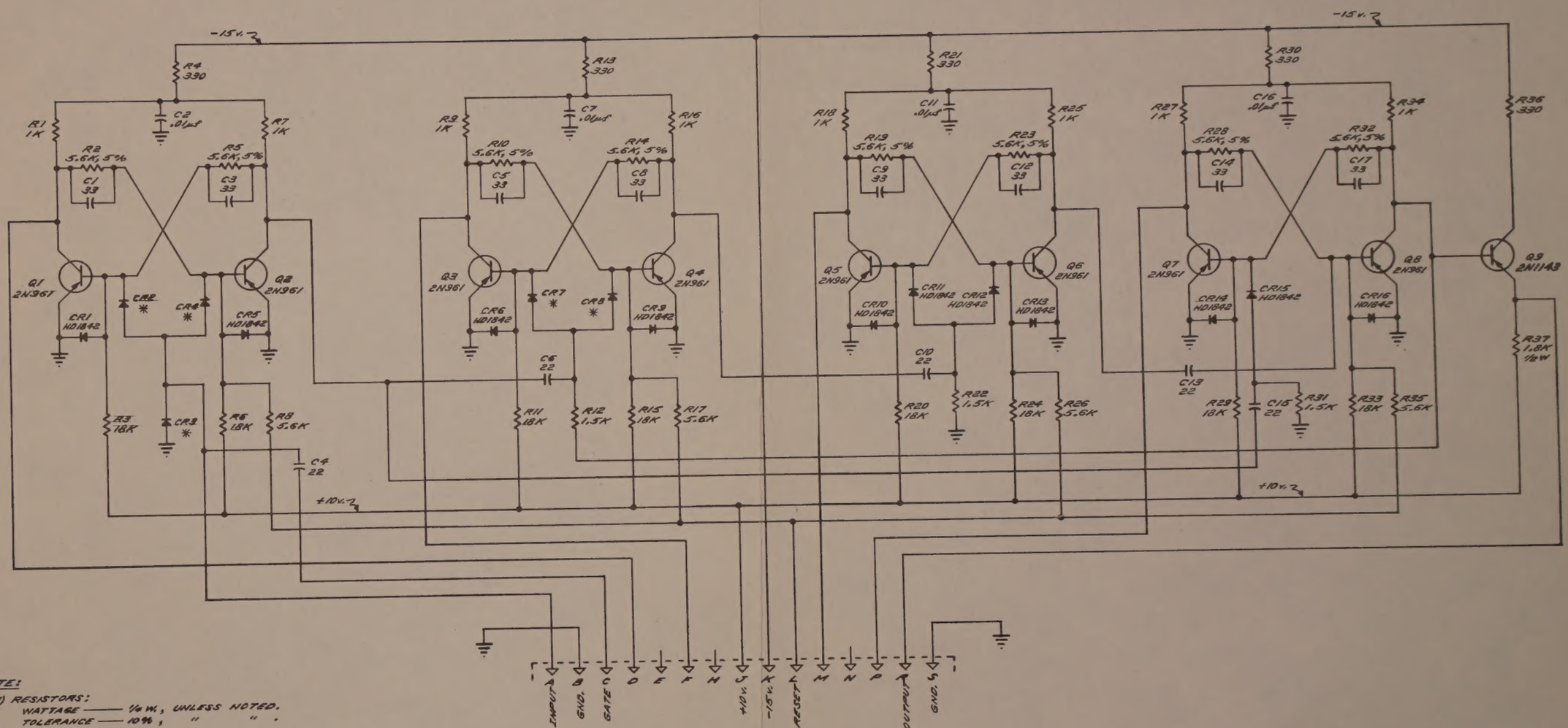
PARTS LIST

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
C1	637-824010	Capacitor, F. Mica, 33pf, 300V, 5%	8
C2	633-804717	Capacitor, F. Cerm., 0.01μf, 500V	4
C3		Same as C1	
C4	637-824008	Capacitor, F. Mica, 22pf, 300V, 5%	5
C5		Same as C1	
C6		Same as C4	
C7		Same as C2	
C8 & C9		Same as C1	
C10		Same as C4	
C11		Same as C2	
C12		Same as C1	
C13		Same as C4	
C14		Same as C1	
C15		Same as C4	
C16		Same as C2	
C17		Same as C1	
CR1	755-824300	Diode, Germanium, type HD1842	11
CR2	755-815561	Diode, Silicon, 75 PIV, 10ma, 1V min. fwd.	5
CR3 & CR4		Same as CR2	
CR5 & CR6		Same as CR1	
CR7 & CR8		Same as CR2	

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
CR9 thru CR16		Same as CR1	
Q1	755-817811	Transistor, Germanium, PNP, 150mw	8
Q2 thru Q8		Same as Q1	
Q9	755-823145	Transistor, Germanium, PNP, 300mw, max.	1
R1	601-823111	Resistor, F. Comp., 1K, 1/4W, 10%	8
R2	601-822397	Resistor, F. Comp., 5.6K, 1/4W, 5%	8
R3	601-823948	Resistor, F. Comp., 18K, 1/4W, 10%	8
R4	601-823935	Resistor, F. Comp., 330Ω, 1/4W, 10%	4
R5		Same as R2	
R6		Same as R3	
R7		Same as R1	
R8	601-823944	Resistor, F. Comp., 5.6K, 1/4W, 10%	4
R9		Same as R1	
R10		Same as R2	
R11		Same as R3	
R12	601-823112	Resistor, F. Comp., 1.5K, 1/4W, 10%	3
R13		Same as R4	
R14		Same as R2	
R15		Same as R3	
R16		Same as R1	
R17		Same as R8	
R18		Same as R1	
R19		Same as R2	
R20		Same as R3	
R21		Same as R4	
R22		Same as R12	

Detail No.	Beckman Stock No.	Description	Qty./ Ass'y
R23		Same as R2	
R24		Same as R3	
R25		Same as R1	
R26		Same as R8	
R27		Same as R1	
R28		Same as R2	
R29		Same as R3	
R30		Same as R4	
R31		Same as R12	
R32		Same as R2	
R33		Same as R3	
R34		Same as R1	
R35		Same as R8	
R36		Same as R4	
R37	601-008079	Resistor, F. Comp., 1.8K, 1/2W, 10%	1
	864-412958	Pad, Transistor	9

MODEL 862
DECIMAL COUNTING UNIT
SCHEMATIC DIAGRAM 22



NOTE:

1) RESISTORS:
   WATTAGE —— ½ w., UNLESS NOTED.
   TOLERANCE —— 10% , " " .
2) CAPACITORS:
   CAPACITY —— IN P.F, " " .
   VOLTAGE —— 300v., " " .
   TOLERANCE —— 5% , " " .
3) .01μf DISC ARE -20 +80 %, 500v.
4) * - DIODES ARE TO BECKMAN SPEC. PART NO 755-815561.